Quality Assurance Project Plan
Lake Stevens and Tributary Streams, Fecal Coliform Bacteria Total Maximum Daily Load Monitoring

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By

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QUALITY ASSURANCE PLAN PROJECT

PROJECT DESCRIPTION

HISTORICAL INFORMATION

Water quality in the Lake Stevens watershed, and its outlet, and Catherine Creek are of primary concern. Phosphorus and fecal coliform bacteria are known to exceed state standards in these watersheds. Lake Stevens was placed on the 303(d) list in 1998 due to exceedance of allowable phosphorous levels. A hypolimnetic aeration system was placed in the lake in 1994 to increase oxygen levels and control blue–green algae within the lake in the summer months. The installation of the aerator has significantly reduced the levels of phosphorous within the lake. However, currently, the Lake Stevens area is experiencing a rapid increase in urban growth, which can contribute to increased levels of pollutants.

Fecal coliform problems have also been documented in the tributaries to Lake Stevens and in Catherine Creek through monitoring by the city of Lake Stevens and Drainage District #8 (Table 1). A general discussion of bacteria levels and subwatershed characteristics are discussed below:

Table 1. Historical Fecal Coliform data from Lake Stevens and its tributaries (2003-4).

	Stevens Creek	Lundeen Creek	Catherine Creek (North)	Kokanne Creek	Catherine Creek (South)
Sample #	7	7	4	4	9
Minimum Dissolved Oxygen Level	5.1	8.2	7.4	7.8	6.8
Annual Geomean	19	200	26	230	407
Meets upper 10th percentile criteria	Yes	No	*	*	No

Stevens Creek—Stevens Creek has good buffers on its lower end with residential housing lining those borders. The upper part of the stream appears to be rural residential based on aerial photography. During the winter months, bacteria levels are within the state geometric mean standard of 50 cfu/100mL (same criteria for all of the creeks drain to Lake Stevens) and meets the 90th percentile standard. The May and June 2004 samples were 60 and 200 cfu/100mL, respectively. Thus there is too little data to determine dry weather compliance but the numbers suggest dry weather bacteria levels may be a problem. Dissolved oxygen levels met the new state standard of 9.5 mg/L only in February 2004. Oxygen but were below 6.0 mg/L on all other occasions.

Lundeen Creek—Lundeen Creek appears similar in land use to Stevens Creek, although the buffers in the lower basin are smaller and residential density seems a bit higher. Although bacteria levels appeared to improve in the winter, the geometric mean for the

monitoring period was 200 cfu/100 mL. Thus, there is need for improvement in bacteria levels. The highest values were 570, 720, and 1,600 cfu/ 100 mL. Dissolved oxygen levels met standards year-round in Lundeen Creek

Stitch Outflow Channel (at UTC rd.)—The Stitch Lake basin is a combination of rural residential and high density residential properties. Much of the creek is well buffered. Development pressure is increasing in the south end of Lake Stevens in recent years. Bacteria levels were better in the wet season but still far from meeting standards. The geometric mean for the monitoring period was 162 cfu/100 mL and the three highest values (April-June 2004) were 1,500, 920, and 840 cfu/100 mL, respectively. Dissolved oxygen levels were met only during January, February, and March 2004. The lowest D.O. values were seen in the drier months. Stitch Lake may be a large wetland complex that contributes to the low D.O. values—more research is needed on this.

Cedar Cove Outflow—The majority of the Cedar Cove watershed is rural residential. Stream buffers appear quite small in a number of areas looking at the Snohomish County SCOPI aerial photography. Similar to the Stitch Lake basin, bacteria levels improved in the winter for several months but quickly deteriorated with the onset of drier weather. The highest bacterial levels were 400, 800, and 330 cfu/100 mL in Nov. 2003, May 2004, and June 2004, respectively. Only in February did dissolved oxygen levels meet state standards. No flow data was provided, but the 0.47 mg/L D.O. value for June 2004 suggests that the creek may have been drying up. More research is needed to determine the cause of the extremely low D.O. values in April-June 2004.

Kosche Outflow—The Kosche watershed is a mixed use watershed with some forested area, agricultural/wetland complexes, and higher density residential. The bacteria levels were poor—the geometric mean for Nov. 2003 through June 2004 was 163 cfu/100 mL. The highest values occurred during drier weather: 1,100, 680, and 460 cfu/100 mL, during April, May, and June 2004, respectively. Dissolved oxygen levels were never higher than 5.6 mg/L (Feb 2004) and reached a low of 0.27 mg/L in June 04. The WA State WRCS GIS water layer did not show this creek so it is likely very small and may become dry during summer months.

Catherine Creek and 36th— This site showed Catherine Creek water quality just after it entered city limits. It drains a forested and rural residential watershed. There were a very limited number of data point collected (March-June 2004). The numbers were generally lower than the other four sites monitored by the City during this period as well as those measured by Drainage District #8 during the same time period. With only four sampling events, a good assessment of water quality cannot be made. However, it does not appear that the waters are likely to be meeting bacteria standards….at least during dry weather periods.

Catherine Creek and 16th—This site shows Catherine Creek water quality after it passes through the City of Lake Stevens. Water quality appears to degrade significantly compared to upstream results, but there are few data points upstream for comparison. The data is similar to that collected by Snohomish County just downstream—the data is close enough that it should be combined and the city should consider dropping this site for long term monitoring purposes and use data from Snohomish County. Spot temperature readings did not reveal any high measurements above standards . Dissolved oxygen levels were below standards in October and November 2003 (7.8 and 6.8 mg/L, respectively) but otherwise OK. It appears that D.O. levels drop during the dry weather season. Snohomish County D.O. levels for each month were

consistently higher than the City's measurements, although it should be noted that the day of data collection for the city was not included in the final report.

Little Pilchuck and 16th—This site is very similar to the Snohomish County LPIL site so data have been combined for this discussion. Bacteria data were very similar for both sources and showed this site to be in compliance with the geometric mean standard for the last year and slightly out of compliance with the upper 10th percentile criterion. The Little Pilchuck is forested with some rural residential properties. Snohomish County D.O. data showed no problems during the three warmer months of 2004 with values about 3 mg/L higher—unclear what time of day the City data was collected and this will be discussed with them during TMDL discussions.

Kokanee Creek @ Lift Station #1—As with the upper Catherine Creek site, there were only four datapoints for this location. However, it looks clear that this predominately residential area will have difficulty meeting either of the state criteria for bacteria during dry weather. Because flow data was not taken, it is not clear whether or not the creek is preparing to go dry for the summer—other data sets from other areas suggest that bacteria levels increase just before a creek goes dry. Dissolved oxygen levels did not meet standards during the two drier months but the values were both 7.8 mg/L—much higher than some of the Lake Stevens tributaries measured by Drainage District #8 during the same time period.

PROJECT OBJECTIVES

Assessing the existing water quality of Lake Stevens, its tributaries, local drainage outfalls, is a first step in the city's water quality monitoring program. Identifying and locating the sources of any future degradation for the purpose of prevention is also a goal of the program.

City of Lake Stevens has developed a basic assessment and monitoring program as an essential step in maintaining water quality. The program focuses on monitoring levels of fecal coliform, pH, dissolved oxygen (along with percent saturation), conductivity, and the temperature of Lake Stevens and its tributary streams. Turbidity is also measured in the streams. Samples for other parameters such as metals and fecal coliform will be collected and analyzed on an as-needed basis for commercial areas, failing septic systems and other similar investigations.

The city's goal with this quality assurance plan project is to consistently produce accurate, credible analytical data representative of the water bodies from which the data and samples are taken. The goal of this QAPP is also to determine areas with highest bacteria concentrations (high priority areas). Provisions for additional monitoring in high priority areas will be included in order to locate pollution sources where they are not obvious. The city of Lake Stevens will follow the Targeted Implementation Approach (Strategy A), which is included in Appendix 2 of the NPDES phase II permit. Only the bacteria monitoring component of this QAPP is required by the city's NPDES permit. All other monitoring to support the city's goal for clean water are being done voluntarily.

These goals will be accomplished by adhering to established schedules, sampling and testing methods, calibration procedures, maintenance, storage, transportation and record keeping practices as follows:

- All schedules, methods, procedures and practices are established from approved methods as specified throughout this manual. All QA/ QC policies required by those approved methods will be utilized.

- Methods for establishing field sampling protocols, storage, transportation and record keeping practices are derived from The Washington State Department of Ecology and the EPA.

- Equipment protocol and maintenance will follow manufacturer specifications.

- Scheduling and testing site locations are established in consultation with the engineering consultant and are prioritized based upon these factors: consistency with previous data collection sites, sites that are the most representative of outfalls into the lake, accessibility, and sites most representative of the water quality of Lake Stevens Scheduling and frequency are determined by the quantity of data needed to reflect trends in water quality.

- No sample data will be recorded without including results for all analyses of QC samples associated with the data. Data will be entered in indelible ink on printed bench sheets and kept in binders and in electronic form. Data will be kept a minimum of 5 years. All data is reviewed and validated prior to release from City of Lake Stevens. Yearly compilation, analysis, publishing and distribution of data are performed by the engineering consultants. The city will consider entering the data into Ecology's Electronic Information Management (EIM) system prior to the next call for data for the state's Water Quality Assessment.

- Training for Public Works staff will be updated as needed, and no less frequently than twice a year. Records of all training are kept in each trainee's personnel folder.

The Washington State Water Quality Standards set the bar for clean water in Washington Administrative Code 173-201A. Selected standards that apply to the local waters in the Lake Steven's area area shown in Table __.

Water Quality Parameter	**173-201 A WAC Requirements**	
	Category	**Numeric Criteria**
Temperature	Salmonid Spawning, Rearing, and Migration	≤ 16 °C, 7-Day Average of the daily maximum (7-DADM)
	Supplemental Spawning Criteria for the lower	≤ 13 °C, 7-Day Average of the daily maximum (7-

	reaches of Catherine and Little Pilchuck (Feb 15-June 15)	DADM)
pH	Salmonid Spawning, Rearing, and Migration	6.5 – 8.5 SU
Dissolved Oxygen	Salmonid Spawning, Rearing, and Migration	> 8.0 mg/L
Turbidity	Salmonid Spawning, Rearing, and Migration	≤ 5 NTU with background ≤50 NTU ≤ 10% increase with background > 50 NTU
Fecal Coliform	Primary Contact Recreation (all other surface waters not listed below) Extraordinary Primary Contact Recreation (Lake Stevens and tributaries to the lake)	Geometric mean ≤ 100 colonies/100 mL And ≤ 10% geometric mean > 200 colonies/100 mL Geometric mean ≤ 50 colonies/100 mL And ≤ 10% geometric mean > 100 colonies/100 mL

Table __. Water Quality Standards for Surface Waters in the State of Washington – Chapter 173-201A WAC. *Recent changes in state standards indicate that all of the Pilchuck River waters now have an extraordinary primary contact recreation designation—this change is under investigation by the city and local Ecology staff.

SITE

Lake Stevens is located approximately five miles east of Everett in Snohomish County, Washington. Lake Stevens is the largest recreational lake in Snohomish County with a surface area of approximately 1,060 acres and a volume of 67,863 acre-feet. As seen in Figure 1, the lake is large for the size of its watershed.. The total area of the Lake Stevens Watershed is 3,770 acres. Lying within the 3,984 acre Catherine Creek Watershed is Lake Cassidy whose surface area is estimated at 112 acres.

Tributary to the lake are Stevens Creek, Lundeen Creek and Mitchell (Kokanee) Creek located north of Lake Stevens. In addition, as an extension of Stitch Lake, Stitch Creek flows into the lake from the south. Lake Stevens has one outlet known as the "outlet channel" located in the northeast portion of the lake.

Two aquifers supply groundwater within this region. The upper, outwash aquifer supplies the baseflow to the creeks. The extent of this outwash aquifer is limited in the Stevens Creek and Lundeen Creek watershed and cannot support stream flow in late summer. Ground water does support a year round baseflow in the Lake Stevens outflow channel. Since the tributaries to Lake Stevens nearly dry up in the summer, the lake water level may be supported by the water table of the deeper aquifer. Lake Stevens is approximately 150 feet deep and experiences an annual water surface elevation ranging from approximately 209.0 to 213.0 feet in elevation.

DESIGN

The core of the program is a routine monthly schedule of field monitoring for basic parameters in the lake, as well as its tributaries and storm water outfalls. Data will be collected by use of electronic field meters that provide representative measurements of turbidity, pH, DO, (as well as DO saturation in percent), conductivity, and temperature of the water in the major watersheds of Lake Stevens. This data is supplemented by quarterly grab sampling of main tributaries for phosphorous and monthly lake sampling for chlorophyll *a* and phosphorous in Lake Stevens. Grab samples for other parameters such as metals and fecal coliform are collected and analyzed on an as-needed basis for investigations pertaining to commercial sites, failing septic systems and other similar activities. All sample collection shall be conducted on a preset basis as noted in the annual schedule (see Table 1).

The purpose of creating preset and frequent sampling dates is two-fold. First, a preset sampling schedule will, over time, include a proportionate number of high and low values. Thus, a representative sampling of the natural variation will be recorded. Second, a preset schedule allows for planning, scheduling and budgetary review. The sampling locations of Lake Stevens represent the various regions of the lake. Locations and depths in Lake Stevens were selected to meet the specific data collection requirements needed to operate and rate performance of the existing hypolimnetic aeration system used on the lake. Measurements are currently taken near the surface and at the 5, 10, 20, 30, 40 and 44 (bottom) meter depths. During summer stratification of the lake, measurements are also taken at the 2.5 and 7.5 meter range. The sampling locations are identified in Figure 2. Locations were selected from a group of testing sites used during the Lake Stevens Restoration Study of 1983. These locations and depths are examined yearly by the Operation and Maintenance Advisory Committee for the aeration system. This committee is comprised of representatives from Snohomish County, the City of Lake Stevens.

SCHEDULE

The annual schedule in Table 1 describes the frequency of water quality testing for Lake Stevens and its tributary streams. Testing for bacteria, temperature, dissolved oxygen (D.O.), and pH will proceed on a monthly basis except for the period of May through October in which testing will be conducted twice a month. As shown in Table 1, these samples will be collected every month between May and October for both Lake Stevens and tributaries.

Phosphorous samples for Lake Stevens will be taken on the third Wednesday of every month at all three stations in Lake Stevens. Phosphorous for tributary streams will be collected on a quarterly basis (January, April, July, October) but other measures such as temperature, conductivity, D.O., and pH will be recorded every month except for the high frequency monitoring period (May-October) noted above. Turbidity will also be collected throughout these streams on a monthly basis. As noted earlier, water quality grab samples

may be conducted in other areas throughout the watershed on an as-needed basis. Storm water samples will be conducted three times per year (February/March, May/June, and July through September) based on the criteria as explained further in the "Sampling Procedures" section of this plan.

All such schedules will be adhered to unless prohibited by weather, personnel or equipment constraints. Documentation of rescheduling will be recorded along with data collected. Towards the end of December, the public works staff will compile the year's data and related information into an annual report.

PROJECT ORGANIZATION

The City of Lake Stevens, Public Works Department staff is responsible for the sampling, collection and processing of field data. The Public Works Director is responsible for implementation of quality assurance and quality control (QA/QC) policies. An independent, Washington State Department of Ecology accredited laboratory is used for analysis of any parameters outside the accreditation of the Surface Water Management staff. The Public Works Director is responsible to direct staff procedures including: instrument maintenance and calibration, field collection of samples and data, transport of samples, control of chain of custody, operation of testing equipment and flow meters, recording and maintaining data, cleaning, storage and inventory of equipment and supplies.

PROJECT BUDGET

The laboratory budget for monitoring to be performed in 2008 will be less than future years because sampling will not be conducted throughout the year. The table below illustrates the typical annual budget for the long-term monitoring component of this project.

Expenditure Type	Budget Source	Cost ($)
Salaries	City of Lake Stevens	3,250.00
Laboratory Costs	City of Lake Stevens	1,800.00
Transportation	City of Lake Stevens	140.00
Equipment	City of Lake Stevens	3,600.00

Table 3. Projected Monitoring Budget for a typical year

TABLE 1

Annual Sampling Schedule and Frequency for Lake Stevens and Tributary Streams

STREAMS

Stevens Creek TMDL Test Site #1	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Temperature	41.02	34.05	44.90	1x	2x	2x	2x	2x	2x	46.91	43.78	32.52
Conductivity												
Dissolved Oxygen (with % Saturation)	62.0	56.1	62.2	1x	2x	2x	2x	2x	2x	65.2	86.0	67.1
pH	7.41	9.71	8.11	1x	2x	2x	2x	2x	2x	8.04	7.81	10.79
Turbidity												
Fecal Coliform Bacteria	**13E**	**16E**	**12E**	**1x**	2x	2x	2x	2x	2x	**34E**	**32E**	**15E**
Phosphorous												

Lundeen Creek TMDL Test Site #2	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Temperature	41.53	35.24	44.60	1x	2x	2x	2x	2x	2x	47.92	43.93	32.37
Conductivity												
Dissolved Oxygen (with % Saturation)	74.1	56.1	83.4	1x	2x	2x	2x	2x	2x	70.7	75.0	73.3
pH	7.53	11.59	8.66	1x	2x	2x	2x	2x	2x	7.66	7.36	9.86
Turbidity												
Fecal Coliform Bacteria	**140**	**52**	**150E**	1x	2x	2x	2x	2x	2x	**660E**	**75E**	**25E**
Phosphorous												

Catherine Creek (North) TMDL Test Site #3	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Temperature	40.23	37.08	44.82	1x	2x	2x	2x	2x	2x	46.70	44.28	32.99
Conductivity												
Dissolved Oxygen (with % Saturation)	72.1	74.5	79.0	1x	2x	2x	2x	2x	2x	70.7	75.6	76.5
pH	7.70	11.06	8.28	1x	2x	2x	2x	2x	2x	7.81	7.65	9.24
Turbidity												
Fecal Coliform Bacteria	**8E**	**14E**	**20E**	1x	2x	2x	2x	2x	2x	**140**	**40E**	**68**
Phosphorous												

Kokanee Creek TMDL Test Site #4	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Temperature	41.38	38.85	46.35	1x	2x	2x	2x	2x	2x	50.91	43.78	37.41
Conductivity												
Dissolved Oxygen (with % Saturation)	71.9	72.6	165.70	1x	2x	2x	2x	2x	2x	72.3	76.4	70.9
pH	7.99	11.25	8.47	1x	2x	2x	2x	2x	2x	8.21	7.92	9.07
Turbidity												
Fecal Coliform Bacteria	**160E**	**140**	**1030E**	1x	2x	2x	2x	2x	2x	**330**	**150E**	**92**
Phosphorous												

Lake Stevens Outflow Channel TMDL Test Site #5	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Temperature	42.52	41.03	44.27	1x	2x	2x	2x	2x	2x	52.40	50.48	41.45
Conductivity												
Dissolved Oxygen (with % Saturation)	70.6	72.4	98.5	1x	2x	2x	2x	2x	2x	68.7	76.9	68.7
pH	8.63	10.89	7.97	1x	2x	2x	2x	2x	2x	7.85	7.77	9.01
Turbidity												
Fecal Coliform Bacteria	**8E**	**8E**	**2E**	1x	2x	2x	2x	2x	2x	**15E**	**12E**	**10E**
Phosphorous												

Catherine Creek (South) TMDL Test Site #6	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Temperature	44.30	39.14	44.87	1x	2x	2x	2x	2x	2x	56.56	47.48	43.65
Conductivity												
Dissolved Oxygen (with % Saturation)	74.3	72.7	90.0	1x	2x	2x	2x	2x	2x	70.7	76.4	81.2
pH	8.71	10.26	7.78	1x	2x	2x	2x	2x	2x	8.02	7.72	8.94
Turbidity												
Fecal Coliform Bacteria	**25E**	**44**	**100**	1x	2x	2x	2x	2x	2x	**340**	**48E**	**48E**
Phosphorous												

Lake Stevens TMDL Test Site #7	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**Jun**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Temperature	42.16	41.23	44.29	1x	2x	2x	2x	2x	2x	57.0	50.12	40.31
Conductivity												
Dissolved Oxygen (with % Saturation)	64.4	69.5	96.9	1x	2x	2x	2x	2x	2x	70.1	86.0	76.0
pH	7.82	10.16	7.66	1x	2x	2x	2x	2x	2x	8.33	8.05	8.67
Turbidity												
Fecal Coliform Bacteria	**15E**	**4E**	**2E**	1x	2x	2x	2x	2x	2x	**45E**	**12E**	**180**
Phosphorous												

As indicated in this monitoring plan, data is collected at established sites on a regular schedule based on prescribed depths. Most water quality data is recorded by use of electronic meters whereas grab samples are collected for analysis of chlorophyll and phosphorous content. These samples are transported to North Creek Analytical Laboratory or another DOE accredited laboratory for analysis. Additionally, grab samples for other parameters (examples: metals, petroleum, fecal coliform) are collected when field conditions or data collected indicate potential water quality degradation. Such samples are also transported to the independent accredited laboratory for analysis.

Table 2 lists all names, addresses, and phone numbers of parties involved in this long-term monitoring program at the time of this plan preparation

TABLE 2

Members Responsible for the Lake Stevens Water Quality Monitoring Plan

Entity	Name	Responsibility	Contact information
Snohomish County SWM	Gene Williams	Assists in quality assurance che on data	2731 Wetmore Ave, Everett, WA 98201 (425) 388-3464
City of Lake Stevens, Public Works Department	David Ostergaard	Public Works Director	1812 124th Ave NE, PO Box 257, Lake Stevens, WA 982 (425) 737-6320
City of Lake Stevens, Public Works Department	Arnie B. Clark Senior Engineering Technician	Performs water quality testing and prepares reports for review by the Public Works Director	1812 124th Ave NE, PO Box 257, Lake Stevens, WA 982 (425) 737-6320

DATA QUALITY OBJECTIVES

PRECISION

Precision will be assessed by measurement of field and laboratory replicate samples. Field replicate samples will be taken for ten percent or greater of the water quality samples taken throughout the sampling day as a method of verifying data and ensuring data quality. Additionally, laboratory replicates will be analyzed for a minimum of 5% of the samples. If the relative percent difference (RPD) exceeds 20% for field replicates or 10% for laboratory replicates for any parameter, steps will be taken as necessary to adjust, qualify, discard or take additional samples as needed. This level of precision is adequate to determine in a statistically significant manner the presence of all analytes of interest.

TABLE 3__ – Measurement Quality Objectives.

Parameter	**Accuracy** (% deviation from true value)	**Precision** Relative Standard Deviation (%)	**Bias** % deviation from tru value	**Required Sensitivity, Reporting Limit or Range**
Temperature	±0.1º C	---	---	-5 to 45 deg C.
pH	0.1 unit	0.05 SU	0.1	4 to 9 SU
Dissolved Oxygen	±0.3 mg/L or ±2% or reading whichever is greater ±2% air saturation or ±2% of reading, whichever is greater	<5	5	0.10 mg/L, 0-20 mg/L range
Turbidity	±2% of reading, plus stray light from 0-1000 NTU	<10	N/A	0.10 NTU, 0-1,000 NTU range
Phosphorus	0.001 mg/L	10%		0.005-0.5 mg/L
Fecal Coliform	N/A	±30%	N/A	1 colonies/100mL of water

BIAS

Bias in measurements may be caused by either calibration error or interferences due to the sample matrix. A maximum systemic bias of 10% is the goal for measuring the parameters listed in Table 1. All protocols will be followed as written to limit sources of bias. Measurement accuracy will be optimized through the use of properly maintained and calibrated field equipment. Calibration verification with check standards will be performed to minimize the bias associated with calibration of this equipment. Water quality samples for phosphorous and chlorophyll *a* will be analyzed by a professional, accredited laboratory. Bias for these parameters will be assessed through standard laboratory operating procedures, including analysis of reference samples and matrix spikes.

REPRESENTATIVENESS

The primary considerations regarded in this plan are homogeneity of the stream and lake, variations in analyte values due to stochastic factors such as flow variation and weather and the choice of sample site selection. The standard procedures used to collect field data and water samples, as described in this plan, will help ensure that the samples collected are representative of the lake and streams at the time of collection.

COMPLETENESS

Completeness is defined as the percentage of valid analytical determinations with respect to the total number of determinations. A reasonable completeness goal is 90%. Typical field problems such as sample container contamination or equipment failure may result in completeness of less than 100%. Another factor, which may reduce completeness, is the identification of nonstandard field conditions (such as poor weather) following data or sample collection. Completeness will be evaluated and documented throughout all monitoring, and corrective action taken as warranted on a case-by-case basis.

COMPARABILITY

This monitoring program will ensure comparability with similar projects by adhering to commonly accepted protocols and procedures wherever possible. The data acquired through this program is intended to compare to data from other water quality monitoring programs in Snohomish County. This data shall be stored in a database, which will be designed to allow transfer of data between this program and similar programs in surrounding areas.

SAMPLING PROCEDURES

OPERATING PROCEDURES

Protocol for collecting water quality data can be found in the standard operating procedures (SOPs) in Appendix B.

Samples

Stream and storm water drainage samples will be collected at outfall locations chosen to provide a well-mixed and representative sample. Seasonal and temporal changes in stream flow will result in slight variation of sampling locations.

Samples taken for bacterial analysis will be taken in pre-sterilized bottles provided by the accredited laboratory and have a one-inch air space remaining before capping.
A clean sample bottle will be uncapped, and lowered immediately into the water to mid-depth in the stream. Bottles with no preservative will be inverted prior to submersion in the stream. Openings of bottles will be turned to face upstream. Collection of surface debris will be avoided with the exception of samples taken for purposes of detecting fuels and oils. A sampling rod attached to the bottle may be used if stream width and depth preclude other methods. Bottles with preservative will be opened and closed underwater.

<u>Turbidity</u>

Samples representative of turbidity levels for analysis with the Lamotte 2020e turbidimeter will be taken with glass sample cells. Only clean 10mL sample bottles, which have been washed with lab detergent and rinsed, will be used.

The cell will be plunged opening down into the water to mid-depth, turned to face upstream then withdrawn and capped. It will then be inserted into the turbidimeter with the match mark on the sample cell aligned with the match line on the turbidimeter for measurement. Results will be recorded on waterproof paper and later recorded electronically. On occasion when time, location or weather will not permit on-site analysis, cells and locations will be numbered with labels on the caps and recorded for later reference and turbidimeter analysis will be performed within the public works water management office.

In instances where construction sites are being monitored, whenever the allowable amount of turbidity (no greater than 5 NTU over background) is exceeded for a period of 48 hours or more, samples representative of the turbidity level will be analyzed at an accredited laboratory. These samples will be taken in 500 mL wide mouth polyethylene or glass bottles at locations upstream and downstream of stream disturbance. Samples will be taken while standing on shore or on in-stream rocks or debris. Streambed disturbance will be avoided. Samples will be stored at $4^{o}C$ for no more than 48 hours before being tested by the accredited laboratory.

Lake and Stream Samples

Some streams may not contain enough flow throughout the summer months to allow for sampling. In the event of extremely shallow or no flow. All sampling schedules will be adhered to unless prohibited by weather, personnel or equipment constraints. Documentation of rescheduling will be recorded along with data collected. All data collected will be recorded in the field. Data will originally be printed in indelible ink on bench sheets and stored in binders. Data will also be transferred and stored in an electronic database.

Storm Event Samples

Storm event samples will be taken three times per year as described in the "Sampling Schedule" discussion below. Phosphorous, turbidity, temperature, specific conductivity, pH and dissolved oxygen will be sampled throughout the storm.

Instruments

All field-testing is performed with equipment that is maintained and calibrated by the in accordance to manufacturer specifications.

Maintenance performed and calibration results are recorded, dated and kept on permanent lab record in bound notebooks within the City of Lake Stevens office.

All staff will acquire, (if needed) the necessary training and certifications in use, calibration and maintenance of equipment.

Field data for selected parameters will be collected by use of the following instruments:

- Hanna HI 9828 Multi-Parameter water quality monitoring instrument maintained and calibrated in accordance with manufacturer specifications.

- Lamotte 2020e EPA certified Turbidimeter. A calibration check is performed prior to each day's usage. A blank check is performed with distilled water.

- Field protocol for turbidity is derived from Washington State D.O.E. criteria for establishing presence of point source pollution in water bodies. Protocol is detailed in Appendix B of this document.

- Field protocol for grab sampling is derived from EPA and Washington Department of Ecology standards for obtaining grab samples. Protocol is further detailed in Appendix B of this document.

- Data will be recorded in a consistent manner as shown in Appendix E. Data will be made available to all interested parties through the annual monitoring report.

- All data recorded will include calibration records including time, dates and results of calibration. Data will originally be printed in indelible ink on bench sheets and stored in binders. Additionally, all data will be entered into a computerized database and stored on floppy disk. Data will be kept for a minimum of three years.

- All lab operations have a written protocol, which provides sequential steps to be followed to ensure consistency of product. All personnel performing any lab operations are trained to follow the protocol requirements for the duty performed as a laboratory accredited by Washington State.

- Gathering of samples, calibration and operation of testing equipment and recording of data are performed by or under direct supervision of the Public Works Director. Review or additional training is held as needed, at a minimum of twice a year. The Public Works Director will be responsible for conducting and/or coordinating all training for the sampling staff. All training is documented and records kept in each employee's personnel folder.

All testing equipment is maintained to manufacturer specifications and recorded in a logbook, which will be located in city's office.

Public Works Staff Responsibilities:

- All samples will be marked with the date time and location of sample with waterproof markers. This information will be transferred to the chain of custody document along with identification of parameter to be tested.

- Samples are handled by two or less persons and only under the direct supervision of the Public Works Director.

- Transport and storage of samples will follow DOE recommended protocol. Collected, capped and marked samples will be place in coolers packed with ice.

- Turbidity samples may be held up to 24 hours if lab analysis is required.

- All other samples are transported for analysis to Test America-Seattle Analytical Laboratory (a DOE accredited laboratory) within 4 hours of collection.

- Samples for fecal coliform may be transported to Lake Stevens Sewer District (a state accredited lab) for analysis.

- No sample will be allowed outside the visibility of the Public Works Staff until relinquished.

- All portable equipment are used by authorized personnel only and secured when not in use.

- The Public Works Director or assigned staff will operate the turbidimeter.

- A report of sampling results will be prepared and logged on permanent lab record, which will be maintained at the city office.

- A chain of custody report will be prepared and provided for all samples transported to Test America-Seattle (or any other DOE accredited laboratory) for analysis.

- Equipment is transported to each testing location and operated by the Public Works Director or assigned staff.

SAMPLING SCHEDULE

Besides the monthly testing schedule, turbidimeter samples will typically be taken on an as needed basis to determine turbidity of suspect water bodies.

When required for monitoring of on-going construction projects, samples will be taken on a designated day and time as established prior to the start of construction. Additional testing periods may be necessary depending on the type of construction activity being performed. .

A designated day and time will be established for samples taken for stream and lake sampling and testing (see Table 1). If low flow conditions exist so that sampling is unachievable, this must be documented on a Field Change Request Form (Appendix D).

All such schedules will be adhered to unless prohibited by weather, personnel or equipment constraints. Documentation of rescheduling will be recorded along with data collected.

Storm water samples will be taken seasonally (three times each year) on Lundeen Creek, Stevens Creek, Catherine Creek and the Lake Stevens Outlet Channel. One sample shall be taken between February/March since this is the timeframe for fry emergence and/or the early growth period for coho and Kokanee.

Outside lab samples for turbidity analysis will be taken of any sampling location for which daily turbidimeter sampling indicates turbidity levels which exceed the State of Washington limits for turbidity (5 NTU over background levels) for a period of 48 hours or more.

No sample will be held longer than 24 hours prior to testing. Preservation of samples will follow DOE requirements as addressed in the referenced protocol sheet (Appendix B).

FIELD NOTEBOOKS

Data shall be recorded on standard data sheets as shown in Appendix E. These data sheets include requests for such information as station name, time and date of sampling, and weather conditions. All original data sheets will be bound and stored at the city office.

CONTAINERS

Samples are taken according to DOE recommendations for sample containers, holding times, and protocol. Samples will be collected in the appropriate container for parameter to be sampled.

SAMPLE IDENTIFICATION

Each sample shall be uniquely identified by location, type of sample (i.e. fecal coliform, etc.) and date. Masking tape may be used as sample label material or labels may be provided by the laboratory. Labels shall be firmly affixed to the sample container, and the sample identifier shall be written on the sample label in indelible ink. Identification numbers shall be recorded on the field data sheets for each sample as specified above, and on the chain of custody/sample analysis request form supplied by the analytical laboratory.

SAMPLE CUSTODY

Custody refers to the physical responsibility for sample identification, integrity, handling, and transportation; this responsibility is considered to be met if samples are in the responsible individual's physical possession, visual range after taking possession, secured so that no tampering can occur, or locked in an access-controlled area. Field sample custody is the responsibility of the assigned surface water staff; laboratory chain of custody is the responsibility of the laboratory's sample custodian. Chain of custody refers to the history of the transportation of the samples from the water quality technician, to the transporter or carrier, and finally to the laboratory's sample custodian while maintaining custody at each step; records of such transfers are maintained on the chain of custody forms provided by the laboratory. Each custodian shall sign the form when relinquishing or accepting sample custody. The laboratory sample custodian shall fax copies of each completed chain of custody to the city, and shall route hard copies with the associated analytical data package. The laboratory sample custodian shall physically certify sample condition, integrity, and identification, and shall immediately report any observed discrepancies in the condition of the samples to the city by fax or telephone.

ANALYTICAL PROCEDURES

Each fieldwork protocol is detailed in the Standard Operating Procedures (SOPs) found in Appendix B. Generally, field work and laboratory procedures for water quality data collection will follow the methods listed in Table 3. In the future, any water quality parameters that may be tested and are not listed in Table 3 will follow those guidelines used at the Manchester Laboratory which are also listed in Appendix C of Ecology's "Guidelines and Specifications for Preparing Quality Assurance Project Plans."

TABLE 4

Analytical Methods

	Method	Source	Sample Analyzed By	Field Replicat	Lab Replicate
Temperature	Electronic Meter	USEPA 1997; manufacturer	Public Works	1/10 samples	N/A
Dissolved Oxygen	Electronic Meter	USEPA 1997; manufacturer	Public Works	1/10 samples	N/A
Conductivity	Electronic Meter	USEPA 1997; manufacturer	Public Works	1/10 samples	N/A
pH	Electronic Meter	USEPA 1997; manufacturer	Public Works	1/10 samples	N/A
Turbidity	Electronic Meter	USEPA 1997; manufacturer	Public Works	1/10 samples	N/A
Bacteria	Membrane Filtration	Standard Methods 9222D	DOE Accredited Test America Lab	1/10 samples	1/session
Phosphorous	Automated ascorbic ac persulfate digestion colorimetric	EPA 365.1/365.2 Standard Methods 4500-P G	DOE Accredited Test America Lab	1/10 samples	1/10 samples

DATA REDUCTION, REVIEW AND REPORTING

GENERAL REQUIREMENTS

All field and laboratory data is reviewed annually by the Public Works Director to determine if the data meets the objectives of this plan. Decisions to reject or qualify data are made collectively by the Public Works Director or assigned staff.

Field data sheets are inspected and initialed by the Public Works Director or assigned staff before leaving the site.

Analytical data shall be prepared by the laboratory for each sample delivery group. The analytical data packages shall include the following:

- A narrative summary of the analyses performed, including identification of any non-conformances that may have affected the laboratory's measurement system during the time period in which the analysis was performed;

- Sample receipt and tracking documentation; sample holding time requirements; copies of completed chain of custody documentation; and documentation of the dates of sample receipt, extraction, and analysis;

- Laboratory Quality Control (QC) data, as appropriate for the methods used, including any matrix spike/matrix spike duplicate data, recovery percentages, precision data, laboratory blank data; and

- The analytical results or data deliverables. Raw data, reduced data, reduction formulas or algorithms, and identification of all data outliers or deficiencies shall be supplied as requested and will not necessarily be a part of every analytical data package.

All analytical data packages shall be reviewed and approved by the analytical laboratory's QA manager prior to submittal the Public Works Director or assigned staff for review and validation.

DATA QUALIFIERS

Each laboratory will have its own list of data qualifiers. The following table lists the data qualifiers used by Ecology's Manchester Lab. The laboratory performing the city's testing

will be instructed to provide a list of relevant qualifiers and supporting documentation so that a cross-reference list can be developed.

Cod	Definition
E	Reported result is an estimate because it exceeds the calibration range.
G	Value is likely greater than result reported; result is an estimated minimum value.
J	The analyte was positively identified; the associated numerical value is the approximate concentration o the analyte in the sample.
N	The analysis indicates the presence of an analyte for which there is presumptive evidence to make a "tentative identification".
NJ	The analysis indicates the presence of an analyte that has been "tentatively identified" and the associate numerical value represents its approximate concentration.
NAI	Not analyzed for.
NC	Not calculated.
R {RE	The sample results are rejected due to serious deficiencies in the ability to analyze the sample and meet quality control criteria. The presence or absence of the analyte cannot be verified.
U	The analyte was not detected at or above the reported sample quantitation limit.
UJ	The analyte was not detected at or above the reported sample quantitation limit. However, the reported quantitation limit is approximate and may or may not represent the actual limit of quantitation necessary to accurately measure the analyte in the sample.

The same qualifier may used for several unrelated problems. For example, the "J" qualifier is used when samples exceed the 24 hour holding time, when there are too many colonies on a plate to make a precise determination, and when non-fecal colonies that may interfere with fecal colonies are observed on the plates. For this reason, laboratory reports should include a narrative that describes why data qualifiers are assigned. The qualifier should be included as the data is processed and reported.

The project manager should review data and data qualifiers monthly to ensure that obvious analytical problems are addressed. The project manager should investigate lab splits that are above 20 cfu/100 ml (smallest count) that vary considerably (10-fold) to determine if lab error is a likely source of the variation. Discussions with the contract lab may be necessary if data qualifiers repeatedly show estimated values or other problems quantifying bacteria levels.

The laboratory will be instructed to contact the city immediately if values over 500 cfu/100 mL are observed.

GENERAL VALIDATION REQUIREMENTS

Expected ranges for water quality are identified on a handout taken out in the field. As part of the sampling protocol, the Public Works Director or assigned staff will report any sample readings out of the expected range to The Public Works Director or assigned staff A second sample will be taken as soon as possible to verify the condition. Ten percent or greater of the water quality samples taken throughout the sampling day will be replicated as a method of verifying data and ensuring data quality. If variation (or relative difference) greater than

20% is found for any parameter, steps will be taken as necessary to adjust, qualify, discard or retake the data as needed.

When field sheets are returned to the office, they are reviewed for completeness, outliers, or inconsistencies and initialed by the reviewer(s). Once the data is entered into the database, The Public Works Director or assigned staff will proofread it against the original data sheets. Errors in data entry will be corrected by either of the assigned staff members. Both reviewers must then initial the field form and spreadsheet. Problems with data quality will be discussed in the annual reports.

All analytical data packages received from the laboratory shall be validated by The Public Works Director or assigned staff in order to ensure that the laboratory has met all contractual requirements and applicable reference method requirements. The review shall include the following items:

- Specific problems associated with the analysis, as identified in the narrative summary;

- Chain of custody records for all samples, emphasizing identification, sampling dates, sample shipping and receipt dates, and sample holding times; cross-check dates against the field sampling records; and

- The completeness of the data package, as necessary to meet the minimum requirements of Section III of this plan, and as necessary to adequately evaluate the data.

All conversations with the analytical laboratory shall be documented to resolve questions related to the data package.

GENERAL REPORTING REQUIREMENTS

As soon as possible after each sampling event, calculations and determination for precision, completeness and accuracy will be made, and corrective action implemented if needed. If data quality indicators do not meet the project's specifications, data may be discarded and re-sampling may occur. The cause of failure will be evaluated. If the cause is found to be equipment failure, calibration and maintenance techniques will be reassessed and improved. Any limitations on data use will be detailed in the annual report. If failure to meet the specifications stated in this plan is found to be unrelated to equipment, methods or sample error, the sampling protocol in question may be revised for the net sampling season. Revisions will be submitted to state and EPA Quality
Assurance Officers for approval.

QUALITY CONTROL PROCEDURES

Quality control procedures provide the means of controlling the precision and bias of the results. Careful adherence to the established procedures for sample collection, preservation and storage as listed below will help minimize errors due to sampling and sample instability.

FIELD QC PROCEDURES

At The Public Works Director's discretion, blind reference samples may be introduced into any sampling round for performance audit purposes. Such samples shall be represented to the laboratory as field duplicates or equipment blanks. Field blank samples shall be prepared by adding reagent grade water to a set of sample bottles provided by the laboratory. These bottles shall be represented to the laboratory as field duplicates or equipment blanks.

LAB QC PROCEDURES

All accredited lab operations have a written protocol, which provides sequential steps to be followed to ensure consistency of product. The manual outlines the quality procedures taken when conducting laboratory tests. Specifically, the following QC parameters will be monitored:

- Method and instrument bias through analysis of blanks
- Matrix bias through analysis of matrix spike samples
- Precision or repeatability through the analysis of duplicate samples or duplicate spikes
- Accuracy through the analysis of surrogate, blank, laboratory control and/or matrix spikes
- Method detection capability through performance of MDL and or IDL studies
- Daily instrument and method performance through analysis of calibration standards.

Section 9.0 of the Manual describes these quality control procedures in more detail. All personnel performing any lab operations are trained to follow the protocol requirements for the duty performed.

PERFORMANCE AND SYSTEMS AUDITS

Systems and data quality audits are performed by the Public Works Director or assigned staff on a yearly basis. Any identified procedural problems will be corrected based on recommendations from the staff.

Each Public Works staff member involved in the monitoring is responsible for observing the data collection techniques and ensuring that data is collected conscientiously, carefully, and in compliance with the written protocols. These staff members are responsible for reporting concerns about particular protocols to the manager. Staff in need of performance improvement will be retrained on-site. If errors in sampling techniques are consistently identified, retraining may be scheduled more frequently. All field and laboratory activities may be reviewed by State and EPA Quality Assurance Officers, as requested.

DATA ASSESSMENT PROCEDURES AND RESPONSE ACTIONS

Review of the field and lab results' ability to meet the objectives stated in this plan is the responsibility of The Public Works Director or assigned staff. Review of these results will be conducted on a monthly basis. Based on the distributions and statistical characteristics of the data, various statistical and probabilistic methods may be used to compare and analyze the data. Any statistical methodologies and assumptions used in the assessment of accumulated water quality data will be discussed in the annual report. The annual report shall be reviewed and approved by all quality assurance parties prior to its dissemination (See Table 2).

Only the reporting of bacteria data is required by the city's NPDES permit. The city is required to report its TMDL/permit compliance activities as part of its annual reporting process. The first annual report is due on March 31, 2008. Data from this project will inform the development of the Bacterial Pollution Control Plan required by the municipal stormwater permit.

The city will report its data annually by calculating seasonal compliance with the geometric mean and upper 10^{th} percentile bacteria quality criteria noted earlier in Table 3. If values of zero are obtained during the study, a value of 1 should be used for computations because geometric means cannot be calculated using zero values. The city will consider the value of flow duration analysis towards the end of the permit cycle.

QUALITY ASSURANCE REPORTS

A year-end, annual report will be produced and distributed subsequent to receipt of finalized data the following year The Public Works Director or assigned staff is responsible for all report production. The Public Works Director or assigned staff is responsible for the distribution of the report. Reports are forwarded to those listed on the distribution list found in Appendix F. At a minimum, this report will consist of data results. Additional sections may include interpretation of data, information on monitoring program status and use of program data by other entities, results of QC audits and internal assessments, and the scope of work for the present year. The content of each year's report will be at the discretion of the Public Works staff and determined in part by data needs expressed by any known end-users.

Discharge Measurement Practices
Surface Water Management

Discussion

Whenever possible, Snohomish County uses practices established by the United States Geological Survey to measure discharge and establish and analyze rating tables.

Measurement

Equipment Used

- Wading rod with a Pygmy Meter or Price AA Meter and an AquaCalc datalogger.
- Crane with sounding weight and Price AA Meter.
- Rio Grande or StreamPro Acoustic Doppler Current Profiler (ADCP).

Staff Value

- Staff value and time of the staff measurement is recorded before and after the measurement and averaged to determine the staff value for the measurement. If the water level is rising or falling during the measurement additional staff values and times may be recorded so a time weighted mean staff value can be assigned to the measurement.

Wading Rod and Crane Measurements

- A minimum of 20 velocity and depth measurements are recorded. The discharge measured in any single velocity measurement section is less than 5% of the total measured discharge.

ADCP Measurements

- Pulley system between the banks is the preferred deployment method.
- A tether line from a bridge or tether lines from opposite banks are used if pulley system is unworkable.
- Four measurements are taken. If the measurements are within 5% of each other, the measurement is complete. If the measurements are not within 5% of each other, an additional four measurements are taken and the value from the eight measurements is used. The average of the measurements is used as the final value.
- A section by section measurement, which follows the same procedure as a wading or crane measurement but uses the StreamPro ADCP to measure velocity and depth, may be used if there is evidence of a moving bed.

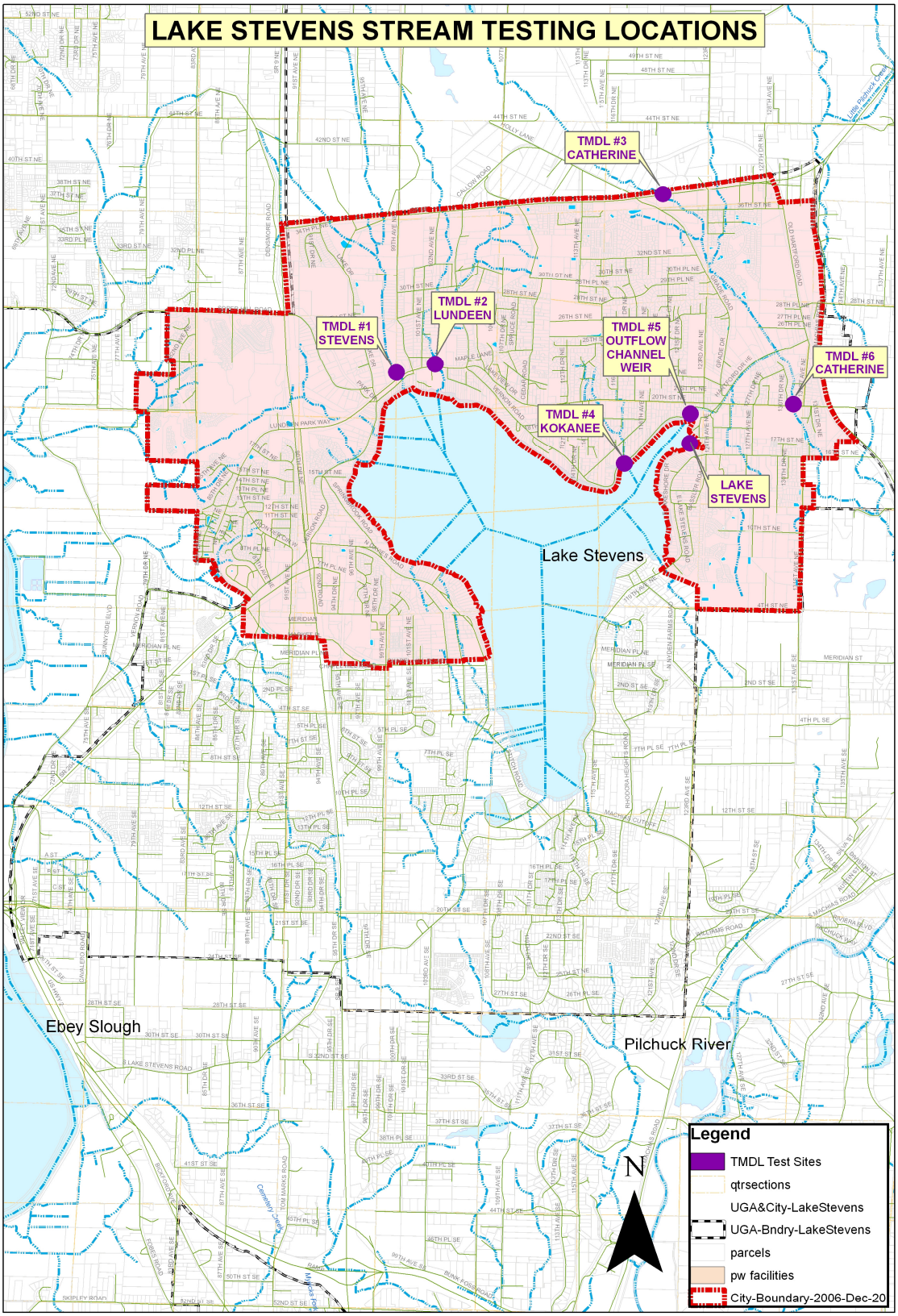
Data Processing

- All measurement data is downloaded to the County computer network and quality checked before being used to establish or analyze rating tables.
- A rating table is generated by establishing a best fit equation on a logarithmic graph using the measurement points selected to define it.

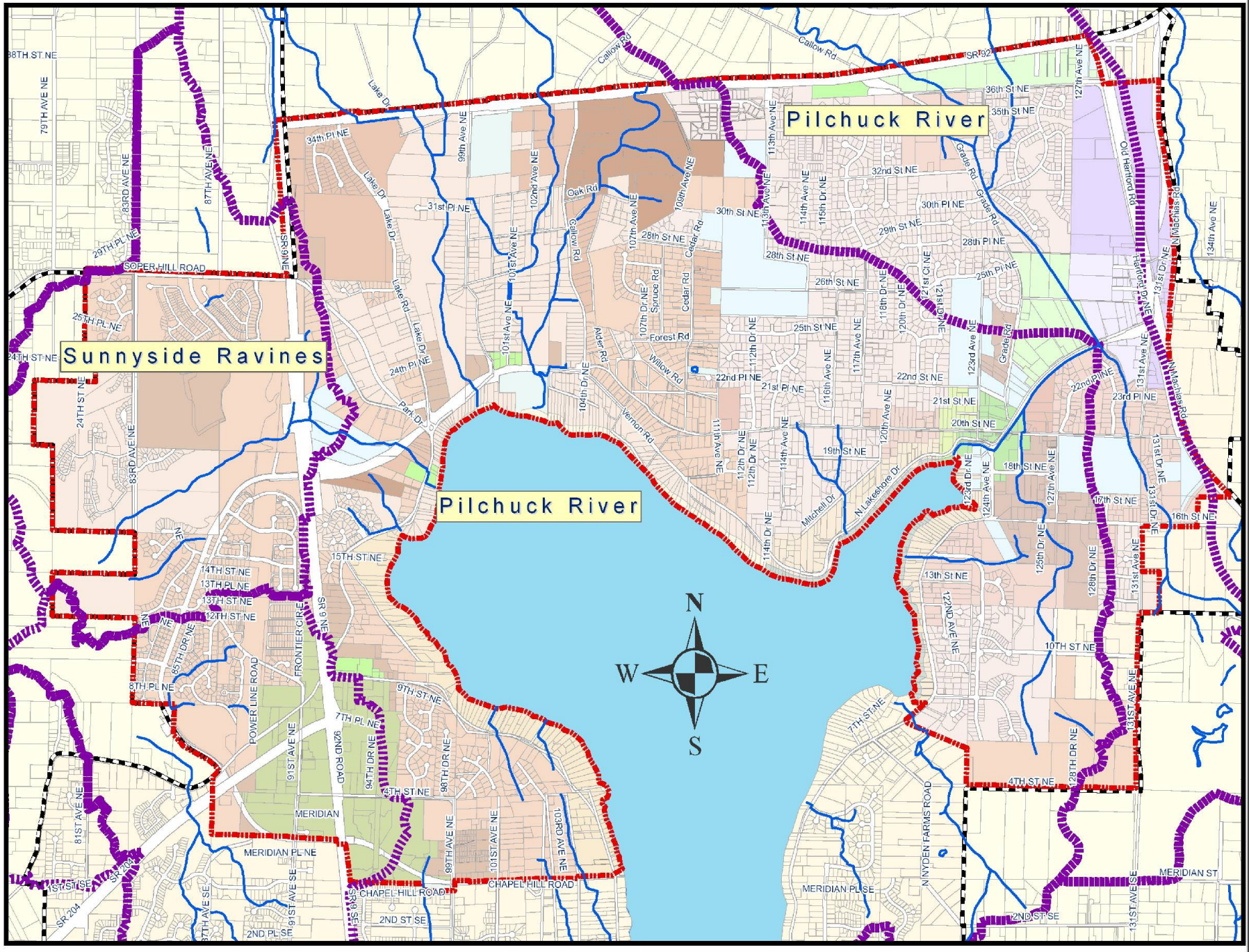
- For a water body with an existing rating table, new measurements are compared to the existing rating table values to look for positive or negative shifts that would indicate gage flow control has changed and a new rating table needs to be established.
- Rating table values are applied to the staff values recorded by the datalogger and any applicable error codes are applied to the discharge value prior to transferring data to the web site database.
- Data is available on the Surface Water Management web site at www.data.surfacewater.info.

Discharge Value Error Codes Used in the Database

- "p" – Used to indicate provisional data that has been released for use but may be revised.
- "r" – Indicates the data value has been changed from a previously released value, values labeled as provisional will not receive this code when they are finalized.
- "n" – Indicates a note has been added to the gage history for a condition not explained by an error code.
- 'x' – Indicates the estimated flow is extrapolated far above or below the nearest observed measurement.
- Other error codes are possible. A link to the complete list is available from the Gage Profile page on the web site once a specific gage has been selected.


LAKE STEVENS STREAM TESTING LOCATIONS
TMDL #3 CATHERINE
TMDL #2 LUNDEEN
TMDL #1 STEVENS
TMDL #5 OUTFLOW CHANNEL WEIR
TMDL #6 CATHERINE
TMDL #4 KOKANEE
LAKE STEVENS
Lake Stevens
Ebey Slough
Pilchuck River
N
Legend
TMDL Test Sites
qtrsections
UGA&City-LakeStevens
UGA-Bndry-LakeStevens
parcels
pw facilities
City-Boundary-2006-Dec-20

Lake Stevens and Tributaries Test Sites



Figuring out Seasonal Means and 90th percentile values*

* note: when you have two values for one day, take the arithmetic mean of the two values and use that number for your geometr mean and 90th percentile calculations. Remember to remove the asterisks so EXCEL will know that it is working with a number.

Step 1: Put your data in the following spreadsheet. If your date distribution changes, then you need t change the month # by hand.

Q-1 Data Analysis

Month #	Date	Value 1	Value 2	Arithmetic Mean	Season
	4/3/2	200	230	2	wet
	5/1/2	530		5	dry
	6/5/2	1200	270	7	dry
	7/3/2	660	570	6	dry
	7/31/2	110	110	1	dry
	9/4/2	90			dry
	10/1/2	220		2	dry
	11/5/2	42			wet
	12/3/2	1300		13	wet
	1/8/2	700		7	wet
	2/6/2	100	120	1	wet
	3/3/2	460	100	2	wet

Step 2: Select data from cells A28 through F39 then Sort on Column F (Season)

Q-1 Data Analysis

Month #	Date	Value 1	Value 2	Arithmetic Mean	Season
	4/3/2	200	230	2	wet
	5/1/2	530		5	dry
	6/5/2	1200	270	7	dry
	7/3/2	660	570	6	dry
	7/31/2	110	110	1	dry
	9/4/2	90			dry
	10/1/2	220		2	dry
	11/5/2	42			wet
	12/3/2	1300		13	wet
	1/8/2	700		7	wet
	2/6/2	100	120	1	wet
	3/3/2	460	100	2	wet

Step 3: Calculate compliance with state standards on each seasonal data set.

Q-1 Data Analysis

Month #	Date	Value 1	Value 2	Arithmetic Mean	Season
	5/1/2	530		5	dry
	6/5/2	1200	270	7	dry

7/3/2	660	570	6	dry
7/31/2	110	110	1	dry
9/4/2	90			dry
10/1/2	220		2	dry
	geometric mean =		2	

4/3/2	200	230	2	wet
11/5/2	42			wet
12/3/2	1300		13	wet
1/8/2	700		7	wet
2/6/2	100	120	1	wet
3/3/2	460	100	2	wet
	geometric mean =		2	

Step 4: Determine compliance with 90th percentile standard….. Given that the seasonal sample size i 6, then our 303(d) listing policy suggests that at least 3 of your values need to be over 200 cfu/100 mL i order to show that water quality standards are not being met. If this condition is not met and some of your samples are still on the high side, then there is insufficient data to determine compliance unless ar equation is used. I prefer to wait until more samples are collected.

In the case of Q-1, both seasons are not meeting standards. I have included an equation for you to use in the future in the table below.

Q-1 Data Analysis

Month #	Date	Value 1	Value 2	Arithmetic Mean	Season
	5/1/2	530		5	dry
	6/5/2	1200	270	7	dry
	7/3/2	660	570	6	dry
	7/31/2	110	110	1	dry
	9/4/2	90			dry
	10/1/2	220		2	dry
		geometric mean =		2	
		90th percentile =		6	

4/3/2	200	230	2	wet
11/5/2	42			wet
12/3/2	1300		13	wet
1/8/2	700		7	wet
2/6/2	100	120	1	wet
3/3/2	460	100	2	wet
	geometric mean =		2	
	90th percentile =		10	